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CORRECTION

U. S. Bureau of Entomology and Plant Quarantine ET-293
A Laboratory Spray Chamber for Producing Deposits of Limited Drop Size

On page 2, paragraph 3, line 4, the word "accentuated" should read "actuated."

U.S. DEPARTMENT OF AGRICULTURE

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X A LABORATORY SPRAY CHAMBER FOR PRODUCING
DEPOSITS OF LIMITED DROP SIZE X

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During the course of investigations of aerial spray deposits at Beltsville, Md.,^{1/} it was found desirable to reproduce, under controlled conditions in the laboratory, deposits similar to those obtained in aerial spraying. The common boom-and-nozzle type of spray apparatus used on airplanes for forest-pest control produces drops with a mass median diameter of about 300 microns. An apparatus was constructed to deliver spray deposit comprised of drops this size or smaller.

Construction

The settling-tower type of spray chamber such as is commonly used for testing insecticides (Campbell et al. 1 and Waters 3) was not suitable for these tests. In it the spray is introduced at the top and settles to the bottom with drops of all sizes intermingled. In these investigations the primary objective was separation of the large drops from the small ones in concentrated solutions such as are used in forest spraying. This was accomplished by constructing a chamber in which the spray can be introduced at one end. As the spray is introduced under pressure, the larger drops are driven farther than the smaller ones; thus, as they settle, there is a gradation in drop size from end to end of the chamber. Samples of deposit taken at different distances from the point of introduction of the spray give different drop spectra.

This chamber is constructed mainly of 24-gage aluminum on a wooden base. Its dimensions are shown in figure 1. The base inside the chamber is crowned slightly to insure drainage of sprays and has two square holes beneath which deposits may be collected. A nozzle and a shutter are located

^{1/} In cooperation with the Division of Farm Machinery, Bureau of Plant Industry, Soils, and Agricultural Engineering.

at one end of the chamber (fig. 2). They are enclosed to confine the excess spray (fig. 3), and provision is made for catching the run-off from the shutter.

The nozzle used is a modified nose-and-throat atomizer. It is prepared by substituting a metal tip and a straight 4-inch metal fluid-intake tube for the original plastic ones and by inserting a No. 22 surgical intramuscular needle into the air outlet to constrict that opening. The end of the air tube is aligned with the outlet hole in the outer tube in order to insure a uniform spray pattern. The fluid-intake tube of the atomizer is inserted in a reservoir of spray material, the level of which is kept constant from an inverted flask above. The arrangement of nozzle, shutter, and reservoirs is shown in figure 2. Air for the atomizer is provided by a small compressor with a ballast tank and reduction valve from a portable air tank or from a cylinder of carbon dioxide.

A pendulum type of shutter controls admission of the spray stream into the chamber. It is attached to a solenoid, which opens it against a spring tension. It is opened and closed through a system of relays and mechanical contacts actuated by flexible rubber tips projecting from a phonograph turntable operating at 78 revolutions per minute (fig. 4).^{2/} The distance between the points on the turntable is variable, so that the shutter can be held open for different periods of time. The shutter can also be operated by hand.

Calibration

The spray chamber is calibrated for drop size and for deposit volume. In calibration for drop size deposits are collected on microscope slides that have been polished after being coated with a silicone preparation. The lens diameters of the drops are measured under a microscope by means of an optical micrometer. Drop diameters are calculated from the lens measurement by use of the following formula:

$$\frac{\text{Lens diameter (microns)}}{\text{Spread factor}} = \text{drop diameter (microns)}$$

The spread factor is a constant for any one spray material and is determined from measurements of a drop formed on a polished surface, the focal length of the lens, and the index of refraction of the material. A graph for determining it is given by Davis (2, fig. 5).

The volume of the deposit is controlled by varying the shutter timing, and any convenient means of analyzing the deposit may be used.

^{2/} The authors are indebted to J. M. Davis for the design and construction of the timer for the spray chamber.

Operation

This apparatus, when used with an air pressure of 20 pounds per square inch, delivers drops averaging 300 microns in diameter at the opening farthest from the nozzle and 80 microns at the nearest opening. Drop size can be varied by changing the distance between the end of the air tube and the spray outlet hole at the nozzle tip. Some atomizers can be made adjustable at this point. Drop size can also be varied to a limited extent by changing the pressure. Increasing it tends to reduce the drop size. Either of these adjustments for drop size will cause slight changes in nozzle output, as will any change in the fluid level or head in the lower reservoir during operation.

Use of the atomizer type of nozzle limits the apparatus to solutions and emulsions. Stable emulsions have been used without any agitation. Suspensions have not been used satisfactorily with the atomizer. However, hydraulic nozzles that will accommodate suspensions can be used.

The time the shutter is held open, and consequently the volume of spray deposited, depends upon the distance between the actuating tips on the turntable. This distance is easily changed by moving one of the suction cups on the glass top of the turntable. Spray deposits are made on glass plates and analyzed after each change in timing until the desired deposit is obtained. For use with oil solutions of DDT a dye tracer method with Dupont oil red has been found most convenient. A direct-reading colorimeter of the Duboscq type makes possible rapid checks on the deposit throughout a series of tests. With drops smaller than 100 microns a draft shield around the falling spray is necessary to prevent drifting.

The spray chamber should be operated where there is plenty of ventilation. With continuous operation the finer portions of spray, which are of aerosol size, may escape into the room as a source of contamination of materials and equipment and discomfort to the operator.

This apparatus has proved very effective in the production of spray deposits within the range of those commonly produced by aircraft apparatus. It has been used in screening various spray formulations with relation to mortality and dosage and in drop-size studies. With it deposits have been placed on all sorts of surfaces including that of foliage. It has been of limited value in treatment of foliage, however, because of the small areas that can be covered effectively.

Literature Cited

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1941. Tests on crawling insects. Soap 17(7): 109-111.
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1949. A photographic method for recording size of spray drops.
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[Processed.]
- (3) Waters, Harold A.
1943. General methods and equipment. In Campbell, F. L., and Moulton, F. R., eds., Laboratory procedures in studies of the chemical control of insects. Amer. Assoc. Adv. Sci. Pub. 20, pp. 115-123.

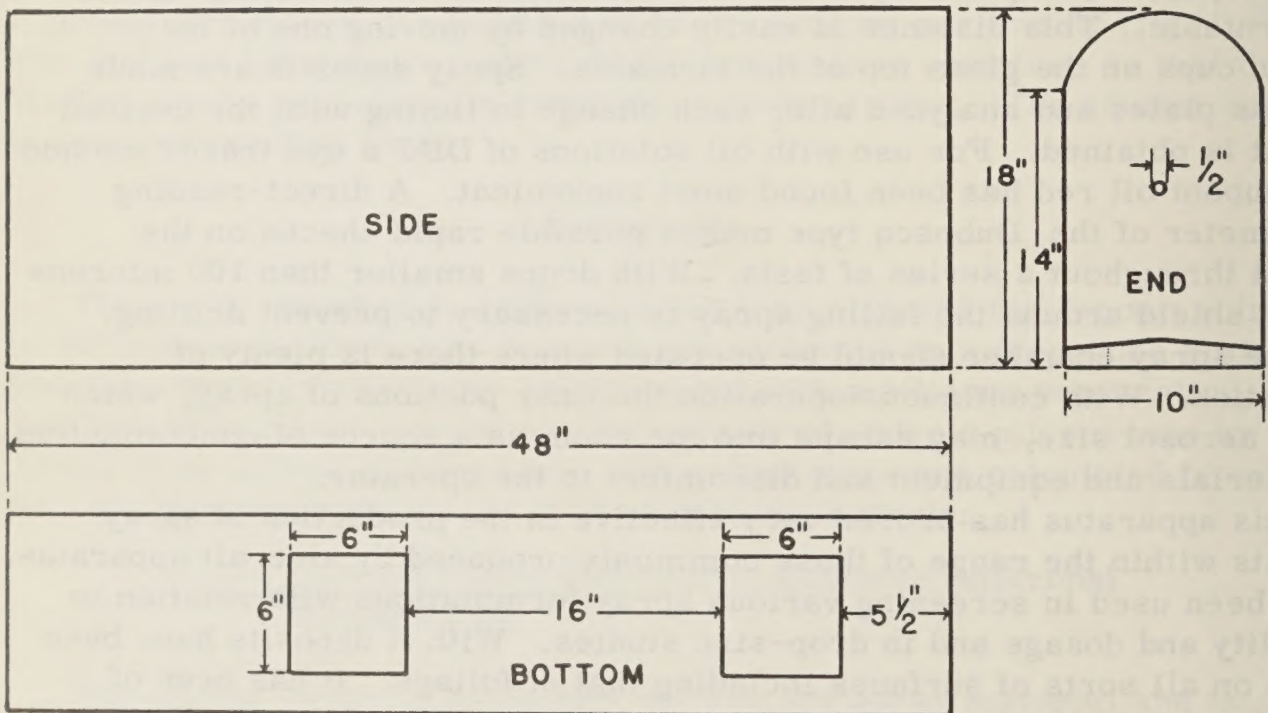


Figure 1.--Diagram of spray chamber, showing dimensions.

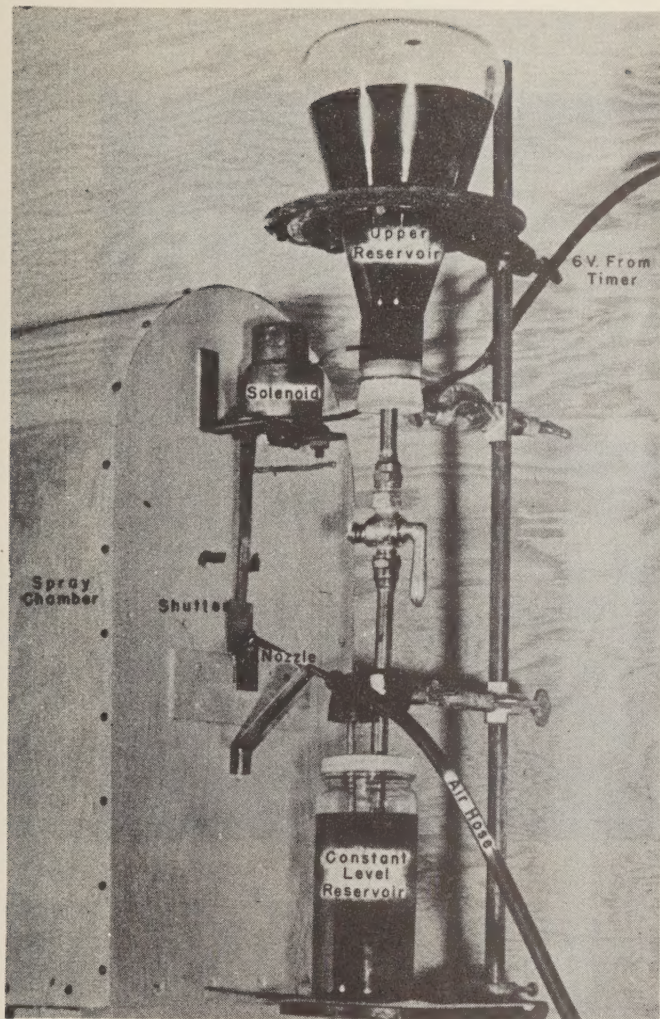


Figure 2. --End view of spray chamber, showing arrangement of shutter, nozzle, and spray reservoirs.

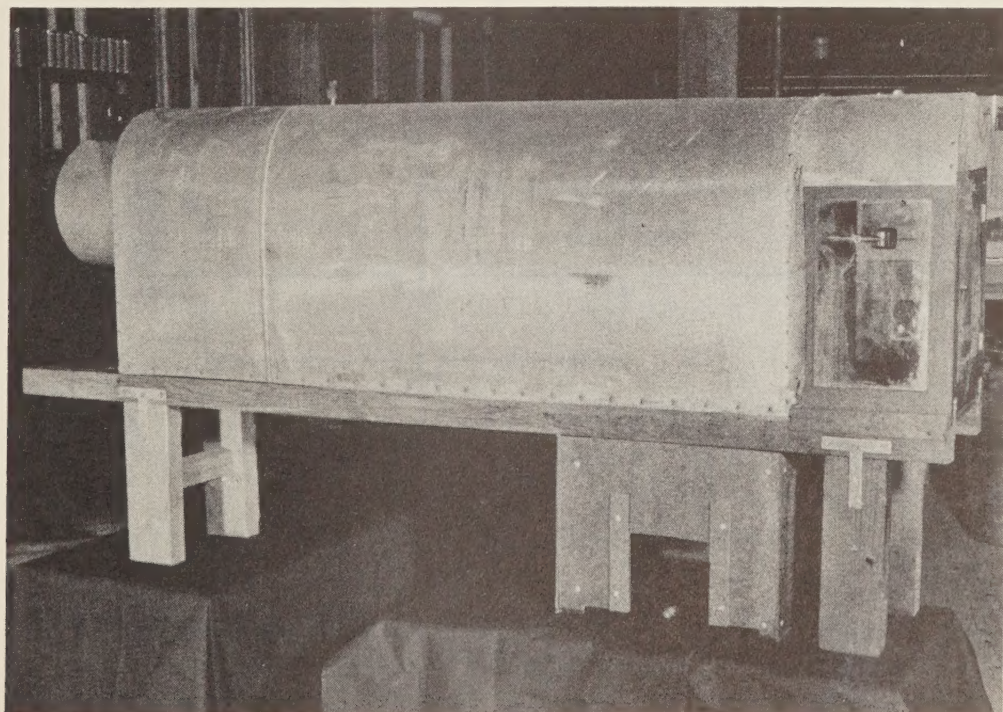


Figure 3. --Spray chamber, including housing for parts shown in figure 2, and with draft shield in place.

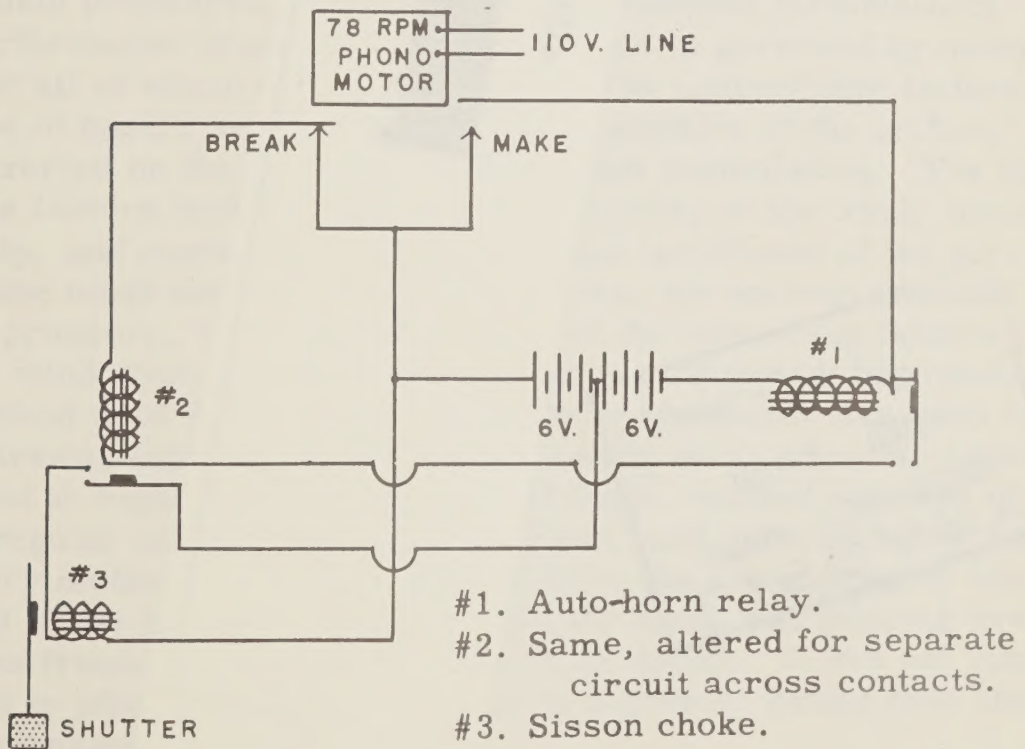
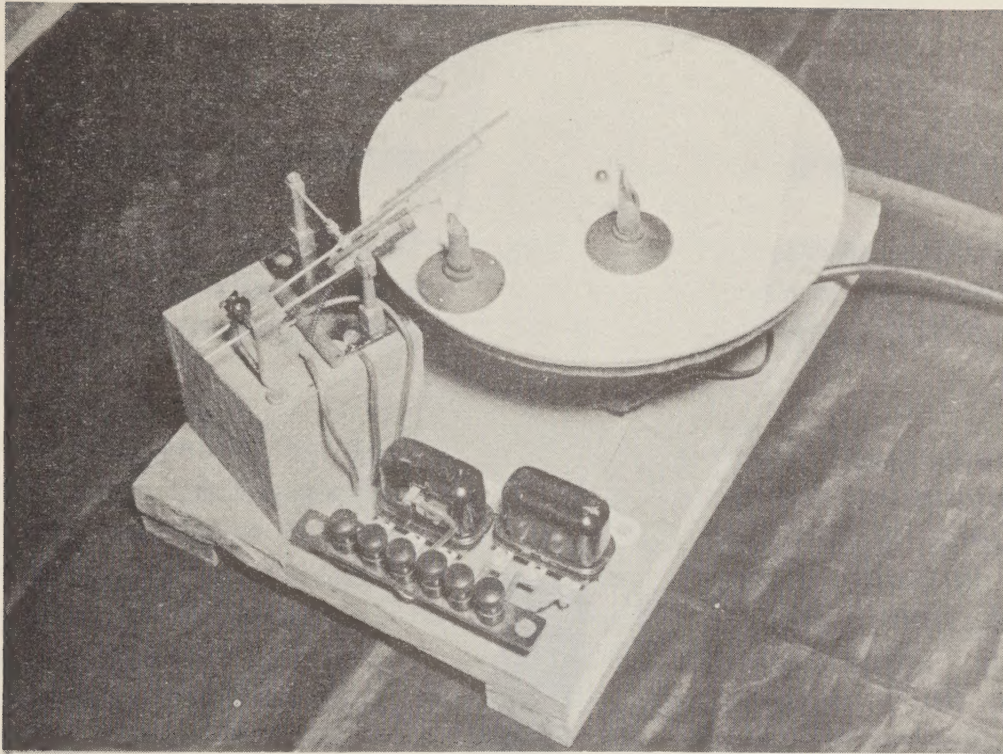


Figure 4. --Timer and circuit diagram.



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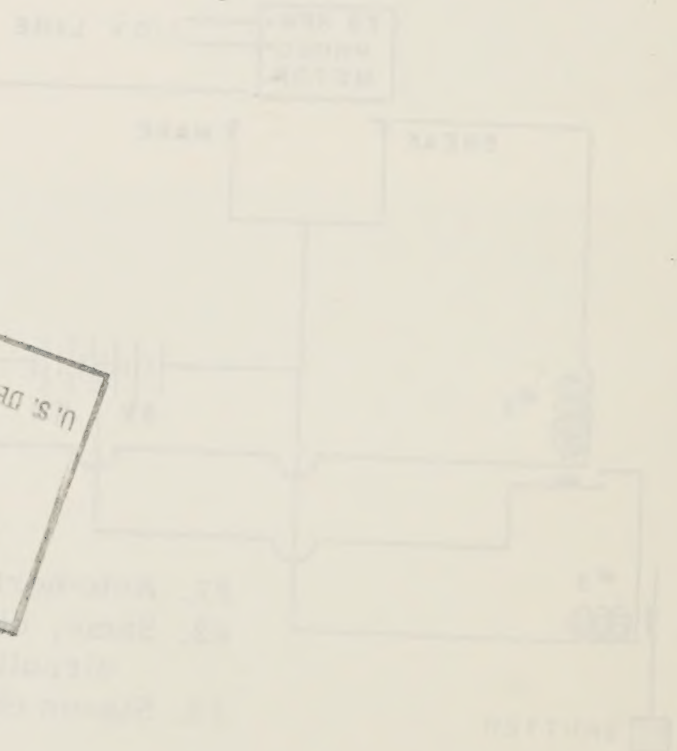


Figure 1 - Transformer and circuit diagram